MARINE REVIEW.

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Deep Waterways Convention.

PRACTICAL FEATURES OF IT IN WHICH VESSEL OWNERS ARE INTERESTED —A SECOND ST. CLAIR CANAL,—WIDENING OF THE LIME-KILNS AND ST. MARY'S RIVER.

To vessel owners and shippers who are interested in improvements of an immediate kind for the advancement of lake commerce, the big meeting of the International Deep Waterways Association in Cleveland this week was especially important on account of the policy outlined by active representatives of the Lake Carriers' Association who were in attendance at the convention. Under the leadership of President Livingstone of Detroit, the vessel owners secured the endorsement of the convention for three important improvements that will be taken up by the Lake Carriers at their next annual meeting, and for which appropriations will be sought from congress at once, without reference to the great subject of a deep water outlet to the Atlantic seaboard.

These improvements are: First, an increase in the width of the Lime-Kiln crossing, Detroit river to not less than 600 feet; second, the construction of another canal at St. Clair flats, and third, an increase to 500 feet in the width of all channels in the St. Mary's river. These are pressing necessities in the present condition of lake commerce and the following resolutions regarding them was adopted by the convention:

A SECOND CANAL AT ST. CLAIR FLATS.

WHEREAS, The phenominal increase in lake commerce has rendered the present St. Clair Flats ship-canal entirely inadequate to the present requirements, and indications point to a further rapid increase; and,

WHEREAS, The capacity of the canal can be doubled at moderate expense by the dredging of a channel 300 feet wide west of the present westerly piers; and,

WHEREAS, There is, with a single channel, constant and imminent danger of blocking almost the entire commerce of the lakes, in case of collision or other disaster resulting in the sinking of a vessel in that channel; be it

Resolved, That it is the sense of this convention that there is a pressing necessity for such channel, and that the same should be constructed within the earliest limit of time consistent with the magnitude of the work.

WIDER CHANNELS IN THE ST. MARY'S RIVER.

WHEREAS, All the cuts and improvements in the channels of the St. Mary's river are of the width of but 300 feet, and the character of the navigation and immense tide of commerce through that river render such narrow channels dangerous and fruitful of disaster, be it

Resolved, That there is that growing increase in the tonnage of the lakes which renders it imperative for the reasonably safe navigation that all such channels and works be increased in width to 500 feet, and it is the unanimous voice of this convention that the government be urged to take up this work at once and carry it to completion as rapidly as possible.

ENLARGEMENT OF THE LIME-KILNS CROSSING.

WHEREAS, More than thirty-five million tons of freight pass through the Detroit river in a single season of about 225 days, and the vessels carrying this immense traffic are compelled to pass through the Lime-Kiln crossing at the lower end of the river, conceded to be one of the most dangerous crossings on the chain of lakes, being a passage cut through rocks 440 feet wide and 20 feet in depth, with sharp turns in approaching it at either end; and,

WHEREAS, The enormous increase in tonnage capacity of steamers and the growing custom of towing with one or more consorts on long tow lines, render this passage more dangerous than heretofore and makes an imminent and pressing necessity for more channel room at that point, be it

Resolved, As the unanimous expression of this convention that immediate steps should be taken by the government to secure an increase in width at Lime-Kiln crossing to not less than 600 feet, and that the secretary of this convention be instructed to forward to each member of congress and of the senate a copy hereof.

In securing the passage of these resolutions, which were introduced by delegates of different lake districts, President Livingstone was assisted by Harvey D. Goulder, counsel of the association, M. M. Drake, J. J. H.

GEO. P. BLOW, U. S. N. — E. C. WHEELER. — FRANK A. FLOWER, Sec'y. — D. A. HOWLAND, International President. — J. S. DUNHAM, Treas. — HON. S. M. STEPHENSON. — GEO. Y. WISNER.

E. V. SMALLEY. — L. E. COOLEY, American Vice-President. — JAMES FISHER, Canadian Vice-President. — T. C. CLARKE.

EXECUTIVE OFFICERS AND PROMINENT DELEGATES—INTERNATIONAL DEEP WATERWAYS CONVENTION.

Brown and J. G. Orr of Buffalo, James McBrier of Erie, J. W. Westcott of Detroit, J. S. Dunham of Chicago and those of the Cleveland vessel owners who found time to attend the convention.

The assemblage of representatives of commercial bodies, statesmen and engineers of both Canada and the United States, who have for several years past been identified with conventions advocating the construction of a ship canal from the lakes to the Atlantic, made up the largest and most distinguished body that has ever dealt with the subject. In addition to the officers and leading members of the association, some of whose portraits are printed herewith, nearly all of the boards of trade and chambers of commerce of the states bordering on the lakes, and several of the far western and northwestern states, were represented. L. E. Cooley, Chief Engineer Randolph and Assistant Engineer Johnson, all of the Chicago drainage canal commission, and H. C. Wisner of Detroit were prominent among the engineers in attendance. It is the intention of the REVIEW to print in future issues some of the important papers that were discussed. One of them by Geo. Y. Wisner of Detroit is printed below.

Nearly all of the papers were in print when the convention opened, and it is the intention also to have the proceedings printed in full. Executive Secretary Flower of West Superior, Wis., has this matter in charge, and if funds are available for the publication of a large number of copies it is probable that they will be distributed quite freely.

Regulation of Lake Levels with Reference to Improving Waterways.

GEORGE Y. WISNER, C. E.
Detroit, Mich.

The depths of channels at the entrances of lake harbors previous to the commencement of improvement by the general government about seventy years ago, were from two to eight feet, and were not generally increased to a depth of twelve feet until after 1864. The natural channel at St. Clair flats was eleven feet for an average stage of water, and about thirteen feet at the Lime Kiln Crossing in the Detroit river, or sufficiently greater than the depth at the principal lake ports that any slight fluctuation of the water levels in these waterways was of but little importance. The phenomenal increase in the lake commerce since 1850 has been such that all improvements of harbors and waterways, which have been undertaken, have generally been discounted by the increased draft of vessels built to such an extent that before such improvements could be completed, every foot of available depth has been constantly utilized, and more urgently asked for.

Under an act of Congress, granting 750,000 acres of land to the State of Michigan for the construction of a ship canal at Sault Ste. Marie, the St. Mary's Falls Ship Canal Company completed two locks in 1855, 350 feet long, 70 feet wide, 11½ feet deep, and 9 feet lift each, at a total cost of $999,802. These locks were soon found inadequate to accommodate the increasing traffic of Lake Superior, and in 1870 the general government commenced a new canal with lock 515 feet long, 80 feet wide, 16 feet deep and 18 feet lift, which was completed in 1881 at a total cost of $2,150,000. The fluctuations of the lake levels, however, are often such that 13 feet to 14 feet is the maximum depth to which vessels can load, and consequently a canal and lock of still greater depth was found to be an absolute necessity.

A new lock 800 feet long, 100 feet wide, 21 feet deep and 18 feet lift, is now being constructed at an estimated cost of $4,739,000, and it is now considered certain that a lock of still greater depth will soon be required.

At the St. Clair flats the channel depth was increased to 13 feet in 1871; to 16 feet in 1873, and is now being deepened to 20 feet; but if one may judge from the unanimous sentiment of the delegates to your Toronto convention last September, works to create a still greater depth must soon be constructed.

If these fixed structures require such increase of depth, the connecting waterways, to give unobstructed facilities for rapid and economical transportation, of necessity will require still greater depths, and since the maximum limits for these channels under the present system of improvement have been nearly reached, it becomes very important to consider new methods for securing such results.

The cost of increasing the depth of the lake waterways to 20 feet has been about $1,500,000 for each foot, and for the principal lake harbors about $3,000,000 per foot of increase, from which it is evident that any permanent deepening of these harbors and waterways may safely be considered worth $4,500,000 for each foot in depth so obtained.

The importance of any slight change in the lake levels is well illustrated by the criticism by literary engineers of pessimistic tendencies upon the deepening of the channel at Lime Kiln Crossing, in the Detroit river, whereby a lowering of the water surface of the river a half-inch may have been produced. It is, however, very strange, that where such small changes have attracted so much attention, variations in depth of several feet, due to natural causes, have received no official attention with reference to their amelioration, and have met with bitter opposition whenever any attempt has been made to secure an investigation of the feasibility of such improvements.

The fluctuations of the water levels of the lakes in extreme cases, amount to about five feet on Lakes Michigan, Huron and Erie. That these variations may be materially reduced there is no doubt, and whatever that amount may be, will increase by a like amount the low water depths of all the lake channels, and by rendering such depths nearly constant, secure much greater economy in vessel construction and transportation.

The data required for a complete investigation of this problem are not to be had at the present time, but the physical facts pertaining to the matter are sufficiently well known to determine within reasonable limits what may be accomplished, and point out the lines on which future investigations should be made.

PHYSICAL DATA PERTAINING TO THE LAKE SYSTEM.

	Lake Superior.	Lake Michigan	Lake Huron.	Lake Erie.	Lake Ontario.	Lake St. Clair.
Mean level above tide water	601.8 ft.	581.3 ft.	581.3 ft.	572.9 ft.	246.6 ft.	576 ft.
Maximum depth	1,008 ft.	870 ft.	750 ft.	210 ft.	738 ft.	
Area square miles	31,200	22,450	23 800	9,960	7,240	410
Area water shed miles	51,600	37,700	31,700	22,700	21,600	
Aggregate area of basin, square miles	82,800	60,150	55,500	32,660	28,840	
Mean annual rainfall	2.6 ft.	2.8 ft.	2.8 ft.	3.1 ft	2.9 ft.	
Variation in annual rainfall	1.5 ft.	1.5 ft.	1.5 ft.	1.7 ft.	2.0 ft.	
Total rainfall on basin, cubic ft. per sec.	187,400	....	450,350	547,000	622,700	
Mean annual evaporation	1.25	1.8	1.8	2.0	2.0	
Max. range of levels	3.5	5.0	5.0	4.1	4.8	
Average annual range of levels	1.20	1 34	1.34	1.55	2.07	
Discharge of outlets, cubic ft. per sec.	86,000	....	225,000	265,000	300,000	
Ruffner 1891, 1892	....	....	....	230,000	....	
Mean date of high water	Sept.	July.	July.	June.		

The annual fluctuation of the water surfaces of the lakes is a function of the amount of rainfall on the respective basins, the time when such precipitation occurs, the amount of evaporation, and the outflow of the lake outlets. The development of the country constituting the lake drainage basins has undoubtedly had a modifying influence on the lake levels. In the original conditions of the lake basins the water from rains and melting snow was retained for weeks in the forest swamps before finding its way through obstructed water courses to the lakes. With the clearing up of the forests, and the development of tile drained farms, these swamps and reservoirs have disappeared, and the water from heavy rains is generally only a few days in finding its way into the lakes, creating rapid rises during wet seasons, and equally rapid fall of the water surfaces during droughts.

Years of heavy and evenly distributed rainfall are generally those when little evaporation occurs, while long periods of dry weather are conducive to producing a maximum evaporation from the lake surfaces. From the most reliable information we have as to the mean annual rainfall and evaporation, for the lake surfaces, the former exceeds the latter by about one foot. Yet, in extreme dry seasons there is no doubt that the annual evaporation from these surfaces exceeds the amount of rainfall, in which case the discharge of the lake outlets becomes less than the drainage from the tributary watershed.

It is to this combination of conditions, working oppositely, that the extreme range of levels for different years is largely due. Years of excessive precipitation are not necessarily years of high water on the lakes, unless the times of such rainfall are so distributed as to produce a maximum effect.

The falls in St. Mary's River, at the foot of Lake Superior, make the fluctuations of that lake dependent only on conditions existing in its own drainage basin. Lake Ontario, having its outflow into the ocean directly through the St. Lawrence River, has a discharge depending on the elevation of the water surface, and inflow depending on the flow of the Niagara River, and the rainfall and evaporation on its own basin. Lakes Michigan, Huron and Erie are so connected with a system of delicately adjusted waterways that any change in the level of one of these lakes has a tendency to produce a corresponding effect in the other two.

The Straits of Mackinaw are so wide and deep that Lakes Michigan and Huron are practically the same level, except when affected by storms and unequal barometrical pressures. For a mean level of lake surfaces the difference in level from Lake Huron to Lake Erie is 8.4 feet, distributed approximately as follows:

St. Clair River,	41 miles.	5.4 feet.
Lake St. Clair,	16 "	0.0 "
Detroit River,	27 "	3.0 "

Any change in this slope produces a corresponding change in the discharge through the waterway, and so delicate is the adjustment that the slope never varies as much as one foot from the above mean and seldom exceeds four inches. For mean high water of the lakes, this slope is 8.2

feet, and for mean low water 8.6 feet, making the mean low water slope greater than that at high water. In extreme cases, the slope at the low water stage exceeds that at high water by nearly one foot, and since the discharge of any river is a function of its cross-section and slope, we have here the anomalous case of a river sometimes having its maximum discharge at its lowest stage. This is an important condition, which has not been given consideration in previous discussions of this problem, and which is really the fundamental principle which should be observed in making investigations to determine the river discharge, and in developing plans for the improvement of the waterway.

The level of Lake Erie, after reaching its maximum stage, commences to fall about one month earlier than Lake Huron and about three months before Lake Superior, showing that these lakes, when acting in their maximum natural capacity as reservoirs, are inadequate to maintain the level of the lake into which they discharge.

Lake Michigan commences to fall at the time the maximum discharge is taking place in the St. Mary's River, and sometimes falls as much as eight inches per month, which would correspond to an actual discharge of 320,000 cubic feet per second in excess of the inflow from the tributary drainage basins, making a total of over 500,000 cubic feet per second actually taken from the volume of water in Lake Michigan and Lake Huron.

Evaporation from the lake surfaces during dry favorable seasons, is probably at times as much as six inches per month, and in connection with the rapidly increasing slope in the St. Clair River, constitutes the principal cause of the rapid fall of the water levels of Lake Michigan and Lake Huron.

These sudden changes of level, corresponding to a rate of discharge of over 500,000 cubic feet per second, seem to indicate that any system of reservoirs which may be devised by damming Lake Superior, or otherwise, will be wholly inadequate to maintain the levels of the lower lakes at a stage very much higher than under existing conditions, and since the variation in the slope of the St. Clair and Detroit Rivers seldom amounts to one foot, it would seem that the natural solution of the problem would consist in maintaining the surface of Lake Erie at as nearly a constant level as possible.

An accurate knowledge of the outflow of the lakes is absolutely essential in designing plans for regulating the lake levels. Unfortunately, such data do not exist at present, and from some inexplicable reason, the departments having the authority to make such determinations, have been very adverse to making any observation to clear up the uncertainty.

In 1841 Messrs. Z. Allen and E. R. Blackwell made a few observations near Black Rock with surface floats for the discharge of Niagara River. These observations, corrected from soundings made by the United States Lake Survey, give a discharge of about 250,000 cubic feet per second for mean level of Lake Erie.

In 1867, 1868 and 1869, parties under the direction of Mr. D. F. Henry, Assistant United States Lake Survey, made three long series of observations with double floats and current meters to determine the discharge of the St. Mary's, St. Clair, Niagara and the St. Lawrence Rivers. The mean of all these observations gave for the St. Mary's River, 86,000; for the St. Clair, 225,000; for the Niagara, 265,000; and for the St. Lawrence, 300,000 cubic feet per second for a mean stage of water in the respective lakes. In 1891 and 1892 the United States Engineer Corps made two series of observations just below the international bridge in the Niagara River, and obtained for a mean stage of water a discharge of 230,000 cubic feet per second.

In the report of this work the authors publish two formulas for computing the discharge, which give results so widely discrepant that no reliance can be placed on either. The difference of 35,000 cubic feet per second between the results of these determinations make it quite evident that more reliable data must be had before the details of plans and estimate of cost for regulating the lake levels can be definitely stated.

A comparison of the annual rainfall on the lake basins, with the respective outflows, shows that the mean discharge is a little less than one-half the mean annual rainfall on the tributary basin, and about one cubic foot per second for each square mile of the basin.

In the observations made to determine the discharge through the St. Clair river, the results were reduced for that of mean stage of Lake Huron, without regard to the existing slope of the river at the time the observations were made. Since, as has been shown, the outflow of Lake Huron depends on the lake level, and also on the difference in level between Lake Huron and Lake Erie, it is somewhat questionable whether the corrections for reducing the result to that of mean lake level were correctly applied.

The action of strong winds on the lake surface often changes the levels from two to three feet; and unless these changes are known, and the proper correction made for the effect on the river discharge, large errors and discrepancies will, very likely, be found in the results. That is, while the observations may be correct for the day on which made, the result for the same stages of water obtained on some other day may be widely different.

The discharge of the St. Mary's, the Niagara and the St. Lawrence rivers depends entirely on the stage of water in the lakes from which it flows, the determination of which is, therefore, a much more simple problem than for the St. Clair.

The plans and methods for improving lake harbors, inaugurated upwards of seventy years ago, are still in vogue; but, judging from the annual complaints in regard to the deterioration of channels at harbor entrances, it is evident that the limiting depths have been reached where such methods can produce permanent results.

The general plan has been to deepen the channels of connecting waterways by dredging, and at the entrance of harbors to construct parallel piers 150 to 200 feet apart, and dredge between. This system for depths of less than twelve feet was very effective, but for greater depths the annual silting up of channels makes the cost of maintenance very great. The width between piers is also much too small for the depth of twenty feet or more, which must soon be obtained for all of the principal lake ports. The government has endeavored to maintain a depth of seventeen feet at these ports for several years; yet, at the opening of navigation for 1895, owing to the low stage of water in the lakes, and to the silting up of channels, but few of the harbors (except on Lake Superior) had navigable channels of over twelve feet. The movement of sand parallel with shores during severe storms is enormous, and wherever these harbor channels have been excavated much deeper than the adjacent bottom of lake, silting is almost certain to occur.

In the new channel, recently cut at the entrance of Toledo harbor, the government engineer in charge reports an annual filling up of 0.5 feet; or assuming the average depth of the cut to be eight feet, the work of maintenan e amounts to the same as for cutting a new channel every sixteen years.

When we take into consideration the fluctuations of the lake levels, it is evident that a channel 21 feet deep at mean lake level will not generally insure safe navigation for vessels of 20 feet draft, except for a period of about three months each year. At the opening and closing of navigation, low water usually prevails, and vessels constructed for a full load on a 20-foot draft will be able to carry only a part of what would be an economical load in a waterway regulated to fixed level.

The total fluctuations of the lake surfaces being over four feet, a well devised system of regulation, which will reduce the range of levels to one foot or less, will increase the low water depth of all the channels three feet, and fix the draft for which vessels may be constructed so as to carry full loads throughout the entire season of navigation.

Two different methods have been advocated for accomplishing this result: First: To make a regulating reservoir of Lake Superior and its tributaries, and turn their surplus waters into Lake Huron at the proper season, to maintain the low water stage at a higher level than under the present regimen; and, second, to regulate the level of Lake Erie with a submerged dam near the outlet of the lake, such as to increase the low-water stage about three feet, reduce the fluctuation to less than one foot, and indirectly through the change of slope in the St. Clair River, reduce the fluctuations of the water surface of Lakes Huron and Michigan to at least one-half that at present.

With the data now at our disposal, it is impossible to state definitely what may be accomplished by either of these plans, or what the exact cost would be to complete them; but the physical facts are sufficiently well known to be able to point out in a general way the results which may be reasonably expected from the execution of either one or both of the plans, and to conclude definitely whether such an undertaking is worthy of an official investigation.

The extreme fluctuation of the water surface of Lake Superior is about 3.5 feet, with a mean fluctuation of only 1.2 feet. With proper regulating works near the foot of the lake, the low water stage might be maintained at least one foot above the present mean level, without damage to any existing structures. The extreme high stage of the lake is approximately two feet above mean lake level, and to avoid all litigation for damage from overflow, the regulation should be such as to prevent this limit from being exceeded. The present outflow for mean level of lake is about 86,000 cubic feet per second, and with regulating works completed, the outflow could probably be increased to 150,000 cubic feet per second for a period of three or four months each year, provided that such a discharge did not create currents in the St. Mary's River of such a nature as to make navigation difficult and dangerous. This amount could not safely be exceeded, and it is very likely the requirements of navigation would limit the maximum safe outflow at a much smaller amount. Lake Nepissing could also be utilized as a regulating reservoir, but the supply from this source would be small compared with that from Lake Superior, and it would not, therefore, be safe to estimate on a total of over 75,000 cubic feet per second in excess of the present mean discharge of 86,000 cubic feet. Since the evaporation and outflow from Lakes Michigan and Huron sometimes amount to over 300,000 cubic feet per second in excess of the influx from rivers and drainage, and that too when the discharge through the St. Mary's River is a maximum, it is quite evident that the supply from the regulating dams alone would have but little effect in checking the fall of the water surfaces of the lower lakes. It has already been shown that the discharge of the St. Clair River varies rapidly with any change of slope, and since the maintenance of a high level in Lake Huron when that of Lake Erie is falling will increase this slope, the St. Clair discharge would be correspondingly in-

[Continued on page 11.]

No Delay on Account of the Canal Accident.

Editor MARINE REVIEW: I am in receipt of yours of the 20th inst., asking information as to the cause, nature and extent of the accident which happened on the 13th inst., to the miter-wall of the upper guard gates of the 800-foot lock, St. Mary's Falls canal.

The upper guard gates and miter-sill had reached that stage when it was desirable to test them, both in regard to construction and adjustment. Accordingly the gates were closed on the miter-sill, and water was pumped into the fore-bay above them. When the head of water reached a stage of 14½ feet above the miter-sill, the top course of masonry in the miter-wall was subjected to a head of 18½ feet at the level of its bed, and the upward pressure (about 1,150 pounds per square foot) proved sufficient to lift that course, which it did with a violent rupture of the mortar between it and the next lower course. The rupture extended throughout the bed, to within about two stones of either end, where the vertical joints yielded. No other vertical joints were disturbed. The upward pressure of the water on the bottom of the gate had not reached the weight of the gate, and of the water which had been pumped into it, so that the accident was in no degree due to the friction between it and the miter-sill, and the latter was not disturbed in its fitting to the top of the miter wall.

The cause of the accident is easily determined. The part of the miter-wall that was lifted, (only a part of the top course,) was laid late last fall, and before the mortar had thoroughly dried out freezing weather came on. The low temperature of the winter caused the stone to contract and disrupt, but probably not to great extent, the bed which afterwards gave way. The crack was so minute as to escape attention, but still large enough to admit water under the pressure due to a head of 18½ feet.

Although a mere film it was, nevertheless, sufficient to transmit the pressure to the full extent of the disturbed bed, and the stones forming the greater portion of the top course were lifted as described, thus violently extending the crack to the portions of the mortar which had not been involved in the original crack.

After the accident occurred the water was drawn off, whereupon the course which had been lifted was relieved of the upward pressure and it returned to its original position, so that an ordinary observer would hardly be able to find the ruptured bed unless he knew just where to look for it. If the top course had been bolted to the others the accident would not have occurred; nor would it have occurred if the mortar bed bonding it to the course below had been intact. The strength of the mortar was ample, as is shown by the fact that the vertical joints were not ruptured except at the two ends of the uplift.

The remedy is a simple one, and easily applied. It is to drill down through the wall for a depth of 13 feet and insert 100 1¼-inch bolts thus tying together the whole 14 feet of the height of the wall. The combined strength of the bolts will be such that the entire wall might be lifted by them. It will not be necessary to reset a single stone, nor will the cost of the bolting be any greater than if the bolts had been placed in the first instance.

From the foregoing it will appear that the accident was neither extensive nor serious, and that the cost of the bolting will be no greater than if it had been done in the first place. It will not result in a single hour's delay in the completion of the lock. The sensational statements which have appeared in print in regard to the matter have no just foundation whatever. It should be remembered that the very object of the test was to ascertain if there were any weak points, and, if so, to apply the requisite remedy. As far as I am concerned I am glad that the defect developed now rather than at some future time when serious delay might have occurred. I may add that every set of gates will be tested in the same manner, and it is not impossible that we may find weak spots in other places, although I do not think we will.

Detroit, Mich., Sept. 21, 1895. O. M. POE.

Compressed Air for Fog Signals.

For some time past the light-house board has been experimenting at the Staten island station with a fog horn apparatus, in which compressed air is used instead of steam, and which is intended for application to light-ships as well as shore stations. A gas motor of the Horns-Akroyd type is used for compressing the air in a tank, frem which it is liberated through the horn. To assure themselves of the efficiency of the motor on shipboard the officials of the light-house service have decided to have one of the motors and its appliances placed on the Winter Quarter shoal light-ship off Atlantic City. Two engines have been put on the ship. One is a duplicate of the other, to replace the one in operation in case of accident. It is believed that the engine will be as successful on a rolling as on a stationary base. The engine is moved by a succession of gas explosions in the piston. By the use of a Clayton air compressor, air will be forced into the large tank to be drawn upon as occasion requires. The blast with the new generator and apparatus will last five seconds, and will be repeated each minute during a fog. The greatest advantage, perhaps, which the new generating power possesses is the quickness with which the sound can be made. Under the old method it took from forty-five to sixty minutes to light the fires under the boilers for the generation of the steam to blow the horns. Now in five minutes air can be compressed in the tank, and a blast of the maximum force can be given immediately. The tank is left full of compressed air after it is used, and contains enough power to keep the horn going for ten minutes. Thus it will be seen that under the new method the blowing of the horns is practically continuous. They can be started before the fog rolls down upon the keeper and kept blowing steadily until the fog lifts. The power can readily be shut off during any temporary lifting of the fog, while formerly it was necessary to keep the fires up and banked for a long time, so as to be sure of being in readiness should the fog roll down again. If experiments on the light-ship at Winter Quarter shoal prove successful the new apparatus will be quite generally adopted.

Compass Bearings on Lake Ontario.

One of the latest circulars from the United States hydrographic office says: "It is very plain that compass bearings cannot be closely relied upon at the eastern end of Lake Ontario. In the neighborhood of the Main Duck islands it has been frequently observed that there is a great deviation of the compass, sometimes as great as a point at a time. This renders navigation very uncertain in thick or foggy weather. This deviation is due, most probably, to numerous superficial deposits of iron ore. An examination of the magnetic observations that have been made in the Province of Ontario, Canada, shows that there are numerous localities in the region immediately above Lake Ontario where there are considerable local irregularities. The dips at Kingston and Belleville, at the foot of Lake Ontario, and at Prescott, on the St. Lawrence river, are among the most irregular recorded on the magnetic survey of Canada, and it is certain that both the compass and the dipping needle will be subject to notable and irregular local influences in the eastern portion of the lake. At Brockville, about twelve miles west of Prescott, and at Cornwall, about forty-six miles east of that place, the anomally disappears."

Stocks of Grain at Lake Ports.

The following table, prepared from reports of the Chicago board of trade, shows the stocks of wheat and corn in store at the principal points of accumulation on the lakes on Sept. 21, 1895:

	Wheat, bushels.	Corn, bushels.
Chicago	14,515,000	1,481,000
Duluth	4,726,000	....
Milwaukee	414,000	....
Detroit	462,000	24,000
Toledo	948,000	138,000
Buffalo	2,079,000	294,000
Total	23,144,000	1,937,000

As compared with a week ago, the above figures show at the several points named an increase of 540,000 bushels of wheat and 207,000 bushels of corn.

Big Steamships of the World.

The following data regarding the world's greatest merchant vessels and vessels of war may prove valuable for reference:

Name.	Length	Beam	Displacement.
MERCHANT STEAMSHIPS.			
Great Eastern	680 feet	83 feet	24,000 tons
St. Louis	535 feet	63 feet	16,000 tons
Campania	600 feet	65 feet	18,000 tons
Teutonic	565 feet	57 feet	12,000 tons
Paris	528 feet	64 feet	13,000 tons
WAR VESSELS.			
Columbia	412 feet	58 feet	7,475 tons
Sardegna	400 feet	77 feet	13,251 tons
Royal Sovereign	380 feet	75 feet	14,150 tons
Terrible	500 feet	72 feet	14,200 tons
New York	381 feet	65 feet	8,480 tons

Germany's mercantile marine is now far greater than that of France, and is second only to the British. In 1894 it measured 1,485,000 tons against 9,585,000 tons for England. The steamer tonnage, which in 1888, was less than the French, amounted to 860,000 tons against 466,000 tons for France.

During the months of July and August the average working force at Cramp's ship yard, Philadelphia, was 6,000.

LAKE ERIE AND LAKE ONTARIO ON ONE SHEET, THE THIRD OF THE HYDROGRAPHIC OFFICE SERIES OF CHARTS, IS NOW IN PRINT AND MAY BE HAD FROM THE MARINE REVIEW, 516 PERRY-PAYNE BUILDING. PRICE 75 CENTS.

Latest Shipping Statistics.

Through the courtesy of Mr. Eugene T. Chamberlain, United States commissioner of navigation, the REVIEW is enabled to print herewith several statistical tables, in which returns regarding vessels owned in various parts of the country on June 30, 1895, are summarized, together with reports covering ship building during the year ending on the same date. In former years these statistics have not been available until November or December when the commissioner's annual report is printed with other reports from officers of the treasury department.

VESSELS OF ALL KINDS (REGISTERED, ENROLLED AND LICENSED) OWNED IN VARIOUS LAKE CUSTOMS DISTRICTS ON JUNE 30, 1895.

CUSTOMS DISTRICT.	Steam.		Sail.		Unrigged.	
	No.	Gross tonnage.	No.	Gross tonnage.	No.	Gross tonnage.
Cuyahoga (Cleveland)...	174	182,473	75	50,408	8	3,963
Huron (Port Huron)......	197	94,930	251	84,016	...	....
Detroit......	162	123,513	114	38,429	12	1,600
Milwaukee......	151	62,204	199	25,723	...	....
Buffalo Creek (Buffalo)..	240	132,541	30	14,520	97	36,636
Duluth......	50	3,343	6	1,645	2	497
Champlain (Plattsburg)	8	786	22	1,323	317	33,082
Miami (Toledo)......	58	14,685	24	7,728	...	....
Niagara (Suspension Bridge)......	13	4,845	8	3,222	2	916
Superior (Marquette).....	123	62,809	45	11,841	...	....
Sandusky	71	3[illegible],869	21	10,473	4	303
Michigan(Grand Haven)	167	24,356	115	9,628	...	....
Chicago......	175	48,266	123	31,321	1	620
Genesee (Rochester)......	17	3,903	4	1,378	1	128
Oswegatchie (Ogdensburg)......	27	18,021	11	3,690	11	1,835
Oswego......	18	4,143	11	2,385	15	1,876
Erie	55	36,129	4	410	...	....
Cape Vincent......	27	1,921	25	1,479	4	275
Vermont (Burlington)...	10	2,930	12	1,023	13	1,351
Dunkirk	3	68	...	....	...	....
Total......	1,755	857,735	1,100	300,642	487	83,082

VESSELS OF ALL KINDS BUILT IN THE UNITED STATES DURING THE YEAR ENDING JUNE 30, 1895.

DISTRICTS.	Steel.				Iron.		Wood.			
	Steam.		Sail and Unrigged.		Steam.		Steam.		Sail and Unrigged.	
	No.	Gr.ton.	No.	Gr. tons	No.	Gr. tons.	No.	Gr.tons	No.	Gr. tons.
Northern Lakes......	7	16,926	3	5,269	......	....	51	9,590	32	4,568
Atlantic & Gulf coasts	21	19,606	5	706	3	2,439	87	8,910	337	28,323
Pacific coast......	1	2,504	......	....	......	....	18	2,539	55	2,101
Western rivers......	3	144	......	....	......	....	57	7,096	14	882
Total......	32	39,180	8	5,975	3	2,439	213	28,135	438	35,874

VESSELS OF 1,000 TONS AND OVER BUILT IN THE UNITED STATES DURING THE YEAR ENDING JUNE 30, 1895.

DISTRICTS.	Steel.				Wood.			
	Steam.		Sail and unrigged.		Steam.		Sail and unrigged.	
	No.	Gr. tons.	No.	Gr. tons.	No.	Gr. tons.	No.	Gr. tons.
Northern Lakes......	6	17,561	2	4 474	2	2,405	1	1,730
Atlantic and Gulf coasts......	3	14,650	...	....	1	2,211	6	8,143
Pacific coast......	1	2,504	...	....	...	....	...	....
Western rivers......	...	....	...	....	...	....	...	....
Total......	10	34,715	2	4,474	3	4,616	7	9,873

VESSELS OF ALL KINDS BUILT IN VARIOUS LAKE CUSTOMS DISTRICTS DURING YEAR ENDING JUNE 30, 1895.

CUSTOMS DISTRICT.	Steam.		Sail.		Unrigged.	
	No.	Gross tonnage.	No.	Gross tonnage.	No.	Gross tonnage.
Cuyahoga (Cleveland)......	4	12,448	...	....	...	....
Huron (Port Huron)......	11	8,741	6	2,658	...	....
Detroit......	4	1,847	1	90	...	....
Milwaukee......	1	11	1	7	1	387
Buffalo Creek (Buffalo)......	8	304	...	....	...	....
Duluth	1	16	...	....	...	....
Champlain (Plattsburg)......	...	....	...	....	6	657
Miami (Toledo)......	2	118	...	....	...	....
Niagara (Suspension Bridge)..	4	279	...	....	3	377
Superior (Marquette)......	4	1,775	4	827	...	....
Sandusky	1	9	...	....	...	....
Michigan (Grand Haven)......	7	343	5	69	..	....
Chicago	5	238	5	4,515	...	....
Genesee (Rochester)......	...	....	...	....	...	....
Oswegatchie (Ogdensburg)......	..	....	...	....	...	....
Oswego......	3	330	...	....	3	250
Erie	2	25	...	....	...	....
Cape Vincent......	1	29	...	....	...	....
Total......	58	26,516	22	8,166	13	1,671

TABLE SHOWING NUMBER AND TONNAGE OF VESSELS OWNED IN THE SEVERAL CUSTOMS DISTRICTS ON THE LAKES ON JUNE 30, 1895.

Ports.	Customs Districts.	Number.	Gross Tons.
Cleveland......	Cuyahoga	257	236,843.50
Buffalo	Buffalo Creek......	376	183,697.49
Port Huron......	Huron......	448	178,946.07
Detroit......	Detroit......	288	163,542.08
Milwaukee	Milwaukee......	350	87,927.24
Chicago......	Chicago......	299	80,206.70
Plattsburg......	*Champlain......	347	35,191.41
Marquette......	Superior......	168	74,650.15
Sandusky......	Sandusky	96	46,644.59
Grand Haven......	Michigan......	282	33,984.57
Erie......	Erie	59	36,538.40
Ogdensburg......	Oswegatchie	49	23,545.59
Oswego......	Oswego......	44	8,404.13
Toledo	Miami......	82	22,412.52
Suspension Bridge......	Niagara	23	8,983.24
Burlington......	Vermont......	35	5,303.67
Rochester......	Genesee......	22	5,408.68
Cape Vincent......	Cape Vincent......	56	3,675 78
Duluth......	Duluth......	58	5,485 04
Dunkirk......	Dunkirk......	3	68.29
	Total......	3342	1,241,459.14

* Largely canal vessels.

Probably for the Union Line.

Buffalo, N. Y., Sept. 26—The new steel steamer for which the Union Dry Dock Co. has taken a contract will be primarily for package freight business, although it will be equipped for any branch of the lake trade, including iron ore carrying. The dimensions are 315 feet keel, 43½ feet beam and 26½ feet hold. This is as large as Chicago docks and the Chicago river will admit safely at present, but there is a provision for lengthening the hull 60 feet as soon as a package freighter can be handled of that size. In this there is a wise looking ahead and a recognition of the fact that a boat of 3,000 tons capacity, even of merchandise, such as this will be, will be entirely out of date in much less time than the natural life of a steel steamer. The added length will make the steamer a 4,000-ton carrier. She will be provided with a triple expansion engine of 24, 39 and 63 inches diameter, with 42 inches stroke, and three Scotch boilers, 12 by 12 feet, capable of withstanding 175 pounds of steam. This power is guaranteed to drive the vessel 12 miles ordinarily and 15 miles in an emergency. Though this is by no means the speed developed by the Owego and Chemung, for which the company has become famous, it is still a good rate; and speed in a heavy carrier is essential on the lakes, at least to the extent that it shall keep a boat up to the wind at all times, so that they need never be obliged to turn back. It is with this idea in view that the steamer's power has been planned.

Requisition for the steel was made last week. It is worthy of remark in this connection that the option for the steel, which was obtained some time ago, was running out and there was fear that it could not be renewed, on account of the advance in material. The builders will not say who the owners are, but if it is not taken by a line it will be by a syndicate.

Chicago River and the Drainage Canal.

The Chicago drainage canal commissioners now figure that four-fifths of the entire canal work will be finished by Jan. 1, 1896. They have decided definitely upon stationary bridges, so that there is, of course, no thought of the canal being used for commercial purposes under present plans. Necessary changes in the Chicago river present another important problem which the canal commission will be called upon to solve. In dealing with this subject, Chief Engineer Isham Randolph of the canal commission says that from notes and soundings taken it was determined that the flow of that stream was now about 150,000 cubic feet per second. This, he said, could be increased to 300,000 cubic feet by the expenditure of a sum of money which he did not consider extravagant. To accomplish this object, it is necessary to deepen the channel, reverse the slope of the bed, and widen the river in some places by setting back the dock line. Some of the bridges would have to be rebuilt; in cases where this was not possible, as at Adams, Jackson and Van Buren streets, and at the Metropolitan Elevated, by-passes would have to be constructed. In order to increase the flow of the river the channel would have to be dredged to a depth of 20 feet, the dock line removed 12 feet and slope made on the basis of one to five. The cost of the work he estimated at about $872,500. The passes around the bridges at the streets named would have to be built under the tracks of several railroad companies. This work would interfere with the roads temporarily. After the passes were completed they would be floored over, and the railroads would have the use of the right of way again.

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MARINE REVIEW

DEVOTED TO THE LAKE MARINE AND KINDRED INTERESTS.

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Lake Freight Matters.

It is absolutely certain now that two or three well known vessel owners entered into a deal several days ago whereby about 200,000 tons of ore was covered at $1 for next year. There is no more business of this kind being done, however, and it is not probable that additional contracts at any price will be made for some time to come, as there is less talk now of ore sales for next year than there was two weeks ago. Vessel owners agree that a final settlement of matters in the iron business may result in the contract freight rate being established at $1, but they have little fear of the rate going below that figure, and on this account they prefer waiting. Excitement in the iron market has been somewhat allayed during the past ten days, and the situation is not as strong as it has been, although there is no fear of any great slump in the demand for iron, which seems certain to hold out well for two or three years. A halt in the market was caused in part by arrangements made by eastern furnaces for the importation of about 100,000 tons of foreign ore for the manufacture of pig iron offered for sale in Pittsburgh. Since the matter has been sifted down, however, the danger of foreign ore is not considered serious. All of the eastern furnace managers have been figuring on the foreign raw material, but they are confronted by high freights and other disadvantageous conditions, and they find that they can not jump into the foreign markets and draw upon them immediately, when for years the foreign producers have been settled down to a business in which the American demand was of little consideration.

As a result of the general tendency towards a settlement of conditions in the iron trade, an immediate effect is noticable in the lake freight market. The principal ore companies have for a week past refused to pay more than $1.25 on ore from the head of Lake Superior, with Marquette at $1.10 and Escanaba at 85 cents. The supply of vessels taking coal on account of fall weather coming on has also increased, and with a disposition among coal shippers to avoid anything like a surplus of supplies, the rate on soft coal to the head of Lake Superior has dropped back to 35 cents with Lake Michigan ports paying 60 and 65 cents.

Two New Whalebacks—Other Contracts.

Capt. McDougall met with other officers of the American Steel Barge Co. in Cleveland, Wednesday, and it was decided to begin work immediately at the West Superior ship yard on a whaleback steamer of 380 feet keel and a consort of 360 feet keel. Some of the officials of the barge company have been opposed to building, but it was finally decided that the condition of business is such that at least one new tow may be added to the company's fleet, and at the same time leave room enough at the ship yard for any outside contracts that may be secured. It is also quite probable that the steamer Colby and three barges, which have been in service on the coast for two or three years past, will be brought to the lakes next spring.

Negotiations leading up to the arrangement of finances for the construction of a very large steel freight steamer are still under way at Detroit and the announcement of a contract from the Detroit Dry Dock Co. for this vessel may be expected almost any time. It is proposed in Detroit to build this steamer on the system of part cash and part bonds. The dry dock company on Wednesday closed a contract for a steel steamer for the lumber trade but details regarding the vessel have not as yet been given out. The Siberian car ferry project has not been closed up as yet, and it is understood that there is some doubt of this important contract being secured, on account of complications regarding various matters pertaining to the construction of the vessels, but it will probably be a month or more before the matter is decided.

Preparations are being made by the Langell & Sons' Co., St. Clair, Mich., for the construction, during the winter, of a steamer of about 2,000 tons capacity. Capt. James Davidson of West Bay City is quoted as saying that he will build six wooden boats of the largest capacity, but this is not positive, as his building operations will undoubtedly depend largely upon whatever success he may have in selling some of the wooden vessels which he now has on hand. The big ship-owning firms will not give any consideration to the purchase of a wooden vessel, and outsiders have not now the opportunities to make money with such a vessel that they had a few years ago.

Promoters of the Cleveland steel canal boat enterprise are engaged in financing the project for constructing twenty-four additional barges for the service between Cleveland and New York. Probably $200,000 will be required for the building of these vessels, if the plan of sacrificing cargo space almost entirely in the steam vessels is carried out, so as to give them additional power to permit of fast towing.

James McBrier of Erie, who was figuring on the construction of a steel tow barge, has about given up his plans, on account of high prices of material. He is of the opinion that with a reduction from the present very high price of material, $15,000 or more may be saved in a tow barge a year hence, and he figures that this additional cost with other conditions will not warrant immediate building.

Murphy & Miller, Cleveland, O., will build at their river bed ship yard, a 60-foot schooner yacht for Lewis Cowles. She will have a 20-ton lead keel and is expected to be fast.

Around the Lakes.

Registered tonnage of the steamer Zenith City is 3,750.49 gross and 3,429.06 net, and her official number is 28,129.

Officers of the Lake Carriers' Association are advised that ore trimmers at Escanaba are talking of another strike unless the rate of trimming is advanced 1 cent a ton shortly, but there is no disposition to take action of any kind in the matter.

Capt. James S. Killeran, who is one of the first officials under John Gordon to leave the Northern Steamship Co., will probably go to the Lehigh Valley line. It is said that he will be succeeded by Capt. Wesley Brown, who was in the North West this season.

Deputy Minister Smith of the Canadian marine department suggests that if any lake vessel master falls in with the sunken wreck or shoal S. E. by S. 5¼ miles from Point Pelee light-house, Lake Erie, he will be rendering the department great assistance if he will drop a buoy on the spot.

About 250 tons of material is used in the design of car dumping machine which the Brown Hoisting and Conveying Co. is constructing for the lake coal trade. Work is well advanced on the first of these machines at Ashtabula, but long delays have been encountered on account of material being scarce.

The fact that the big passenger steamer North West made the passage easterly through Portage Lake canals, a few days ago, instead of going round Keweenaw point, is proof of the claim made some time ago by the engineers, that any vessel going through the St. Mary's Falls canals can pass the Portage canals also.

The 400-foot steamer Zenith City's cargo of 138,000 bushels of wheat, taken from Duluth to Buffalo on 14 feet 4 inches draft, is the largest cargo of grain ever moved from Lake Superior, but it does not amount in gross tons to as much as the first ore cargoes of the schooner Aurania and steamer Victory, which were 3,928 and 3,689 gross tons, respectively, on about the same draft.

The Montague Iron Works, Montague, Mich., will build the new engines that are to be put into the Graham & Morton steamer City of Louisville. They will be fore-and-aft compound, with cylinders 20 and 40 inches by 30 inches stroke. The Montague works will also rebuild the engines now in the City of Louisville for the Graham & Morton tug to be built by E. W. Heath of Benton Harbor, Mich.

Four small schooners, the insurance on which did not amount in the aggregate to more than $50,000, constitute the total losses in the gale of last week, so that thus far the underwriters have not a great deal to complain about, and fortunately there was no loss of life. The lost vessels are the C. H. Johnson, Queen City, A. W. Comstock and E. R. Williams. With high freights this fall it is probable, however, that all vessels will be kept in commission very late in the season, and the risks that will be taken may result in more losses than would occur if tempting freights were not offered.

Letters at Detroit Marine Post Office.

Postmaster John J. Enright of Detroit furnishes the following list of names to which letters uncalled for at the marine post office are addressed:

Bain, Hugh A.	Johnson. Capt. Fred
Bell, Capt. John	Plumb, Miss W. L.
Brooks, Thomas J. 2	Radloff, Fred J.
Clark, Capt. Thomas E.	Shock, Philip H.
Elliot, Capt. A. M.	Weaver, T. J. 2
Mrs. Annie Devere.	Lahart Wick.
Jackson, Capt. M.	Wellock, Richard.

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[Continued from page 7.]

creased, and thus tend to prevent any beneficial results accruing from the regulating works. It would therefore appear that in order to be able to secure any substantial benefit from the regulating works at the foot of Lake Superior, the level of Lake Erie must first be regulated by a dam at the head of Niagara River.

It is a well known fact in hydraulics that where water flows over the crest of a dam or weir, any slight variation of the depth on the crest of such weir will very materially modify the volume of discharge passing over. For instance, if the top of such a weir is two feet below the general level of the water surface of a regulated lake, and a rise of three inches from a heavy rain should occur, the volume of discharge over the weir would be increased 20 per cent.; or, if such were the conditions on the proposed dam for regulating the level of Lake Erie at a time when the discharge was 250,000 cubic feet per second, corresponding to that of the present mean stage, the increase would be 50,000 cubic feet per second; and since the increment for one foot change of level at such stage is probably not far from 33,000 cubic feet per second, the change of three inches above the regulating dam would correspond to that of 1.5 feet under the present conditions of the lake outlet.

A sudden rise of three inches under the existing conditions would not increase the outflow to exceed 10,000 cubic feet per second, from which it is evident that a properly constructed regulating dam at the foot of the lake would greatly increase the discharge of Niagara River for small rises of the lake level, and consequently lengthen the period of maximum discharge and proportionately diminish its volume of flow per second at high stage. That such a dam can be constructed, there is no question; but what its dimensions should be, and what it would cost to construct it can not be stated until the discharge of Niagara River is accurately known.

Since the difference in the levels of the water surfaces of Lake Huron and Lake Erie seldom varies more than six inches from the mean slope of the connecting waterway, it is evident that if the level of Lake Erie be so regulated as to vary but little from its present high water stage, the annual fluctuations of water surfaces of Lakes Huron and Michigan will be decreased so much as to produce the necessary change in slope in the St. Clair and Detroit rivers corresponding to the variation in discharge—a probable extreme fluctuation of less than 1.5 feet.

This result will directly effect the levels of the St. Mary's River below the falls, and will unquestionably add at least two feet to the low water depths of that river.

The laws governing the flow of water over the crests of dams are definitely known, and if the level of Lake Erie be determined, near which it will be safe to regulate the water surface without damage to property, the problem of regulation becomes simply what length must be given to the dam, such that a fluctuation of six inches on the crest will correspond to a variation in overflow equal to the maximum annual variation in the discharge of Niagara River.

The solution of this problem requires an accurate knowledge of the outflow through the Niagara River for all stages of the lake level—data, which at present are so uncertain that the computed outflow by different engineers differs by amounts which would make a large river.

If this project is worthy of official investigation, the first and essential thing necessary is that the physical facts in regard to the water levels and outflow of the lakes be accurately determined. Aside from the important question under consideration, this information is badly needed to settle existing disputes as to what effect certain canal and harbor improvements are likely to have on the channel depths of the lake waterways.

With such a regulating dam in place, the annual discharge of the Niagara will be the same as under the present conditions, but at the beginning of a rise of the lake surface, the dam will add greatly to the outflow and correspondingly reduce the maximum discharge for the high water period.

It is the opinion of the writer that such a dam will be ample to regulate the levels of Lakes Erie, Huron and Michigan, but in case the future development of the lake commerce makes still further improvement necessary, a regulating dam at the foot of Lake Superior would place the levels of the entire upper lake waterway system under perfect control.

Since the water surface of Lake Erie, when properly regulated will not have an annual fluctuation of over six inches, and since the present high water plane of lake levels is 2.3 feet above that of the mean stage, if the regulated plane for mean discharge be fixed at 1.5 feet above the present mean level, the high water stage of the regulated surface would never exceed the present high water plane. And as it is fair to presume that all structures have been built with due regard to safety under existing conditions, no great damage could possibly arise from the improvement.

Since the fluctuation of the regular water surface will be small, all future structures can be built at heights best adapted for economical handling of freight, and have the great advantage of being in such state at all seasons of the year, a condition of affairs all shippers will appreciate.

In a letter published in the Marine Review of September 7, 1893, a distinguished engineer officer says in regard to the effect of such a dam on the level of Lake Ontario: "The result could only be produced by impeding the discharge of Lake Erie, and as the level of Lake Ontario depends on this discharge, it is evident that the level of the latter, as well as of the upper St. Lawrence River, would fall until the discharge over the proposed dam was restored to the present volume. Then the surface of Lake Ontario would begin to rise, and continue rising until the present level was attained. The length of time required to pass through this cycle is indeterminate, but it can be assumed with reasonable assurance that the period would be so long that the people of the United States and Canada interested in the navigation of Lake Ontario, St. Lawrence River and St. Lawrence canals, would so strongly object as to prevent the construction of a dam at the outlet of Lake Erie."

This is a strong criticism from an engineer of recognized authority on such matters, and unless it can be squarely met with legitimate reasons to the contrary, might be sufficient to prevent the enterprise being undertaken.

The area of the water surface of Lake Erie is 9,960 square miles, and of the entire lake basin tributary to the lake 230,000 square miles, or approximately 23 times the lake surface. Since about 50 per cent. of the rainfall on the basin is discharged through the Niagara River, it is evident that a variation of three inches in the rainfall on the lake basin would be equivalent to a volume of water due to a three-foot change in the level of Lake Erie.

Since the variation in the rainfall on the lake watershed is over 18 inches, and produces no disastrous effects on the levels of Lake Ontario, it is difficult to understand why only one-sixth of this volume, if held back by a regulating dam, should produce any noticeable effect whatever.

The work of constructing such a dam would extend over a period of at least two years, which would make the effect only one-half that mentioned above, and the criticism can therefore be dropped as a purely theoretical one.

Cheap transportation depends largely on being able to carry large quantities of freight in full loads, long distances, without change and at rapid speed. To do this, ships must be constructed with due regard to the depths of the waterways which they are to traverse, and since the capacity of a waterway within ordinary limits varies as the cube of the depth, the draught of vessel must be such as to utilize as great a depth as possible, without causing speed to be retarded by too close proximity of keel to the bottom.

For waterways of constant depth, the most economical draught and tonnage for a vessel is easily determined, but where the water levels have fluctuations of several feet, the solution is very complicated and unsatisfactory.

On the lakes, freight vessels have generally been constructed for the deepest summer depth to be expected in the waterways, with the result that during low stage of water only partial loads can be carried, which, with detentions from groundings, greatly reduces the profits of the shipping business.

It would therefore seem almost self-evident that any system of improvement of our harbors and waterways, having for a basis the regulation of the water levels, must have a very beneficial effect in cheapening vessel construction and transportation rates.

It is a well established fact that the tendency of export products is to follow the same lines of transportation used for supplying the necessities of home consumption.

The surplus products of the Northwest will therefore very likely continue to be transported over the water and railroad routes through our eastern cities.

This convention has been convened to devise ways and means to render the cost of such transportation a minimum by setting the proper machinery in motion to have a waterway of a fixed depth of over 21 feet constructed from the lakes to tide water; but unless some radical change is made in the methods of improving the waterways of the lakes, vessels loaded for the full navigable depth of such ship canal will be badly handicapped when chartered for ports beyond the western terminus of the canal during the low water season on the lakes. It has already been shown that the cost of increasing the harbor channels and lake waterways has been nearly $5,000,000 for each foot in depth secured in both, and that under the present system of improvement, such results have not been permanent. It would therefore appear very desirable that an investigation be made of the feasibility of increasing and rendering nearly constant the depth of navigable channels of the lakes, by regulating the lake levels, a d that such investigation should be made by the International Commission to be appointed, and I understand already provided for, to report on the character, route, and cost of a ship canal from the great lakes to the sea.

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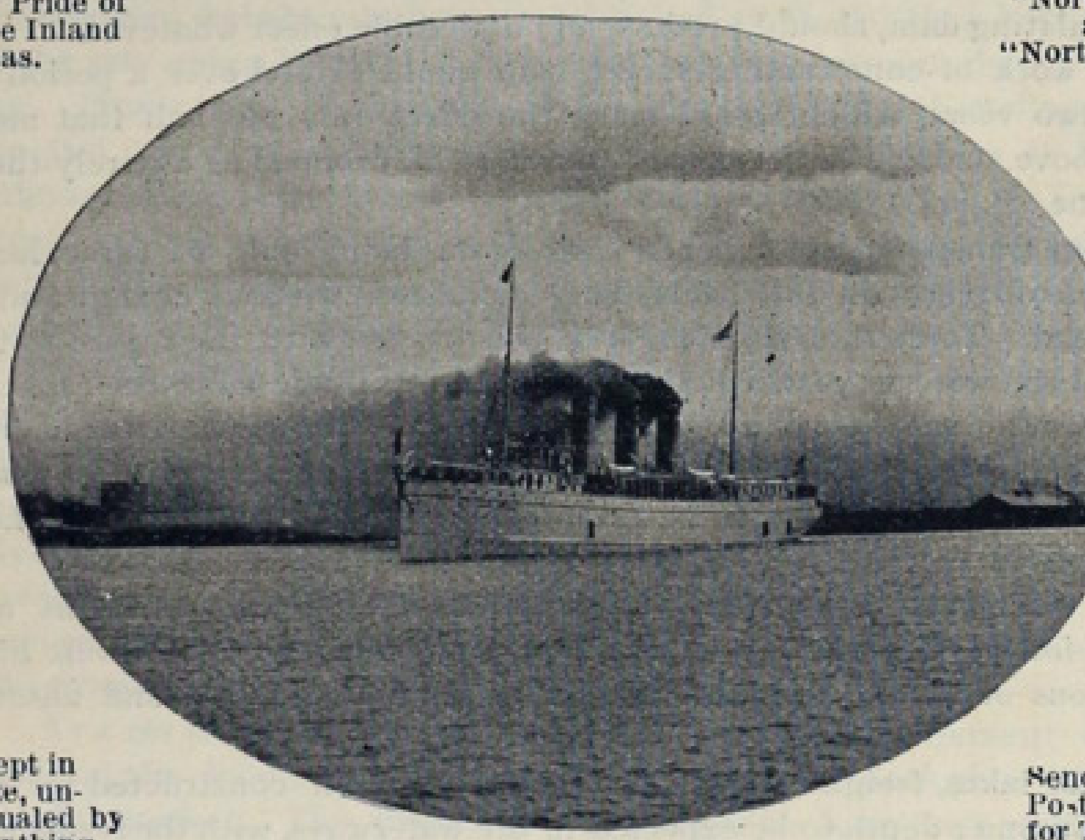

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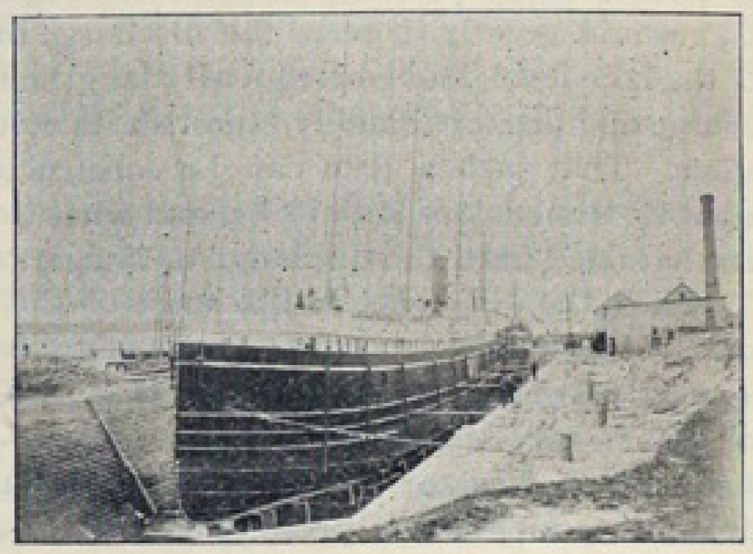

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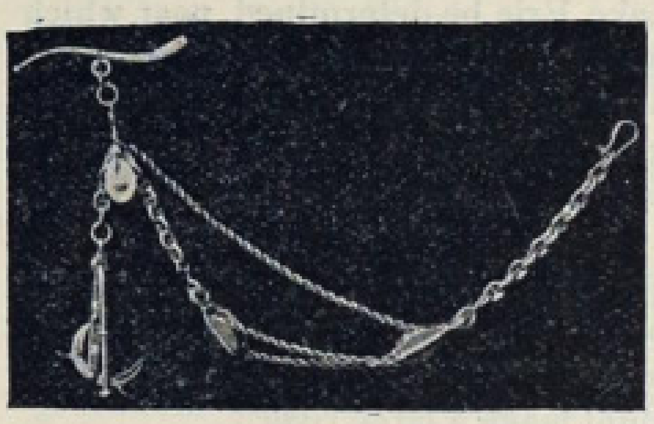

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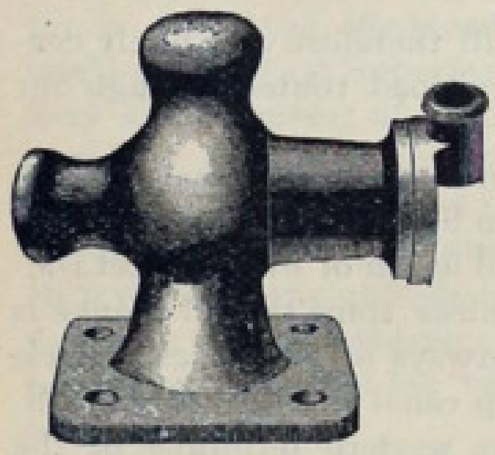

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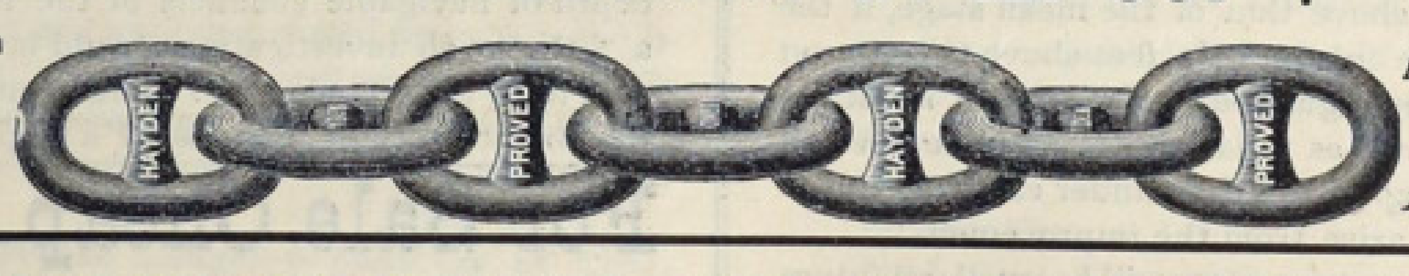

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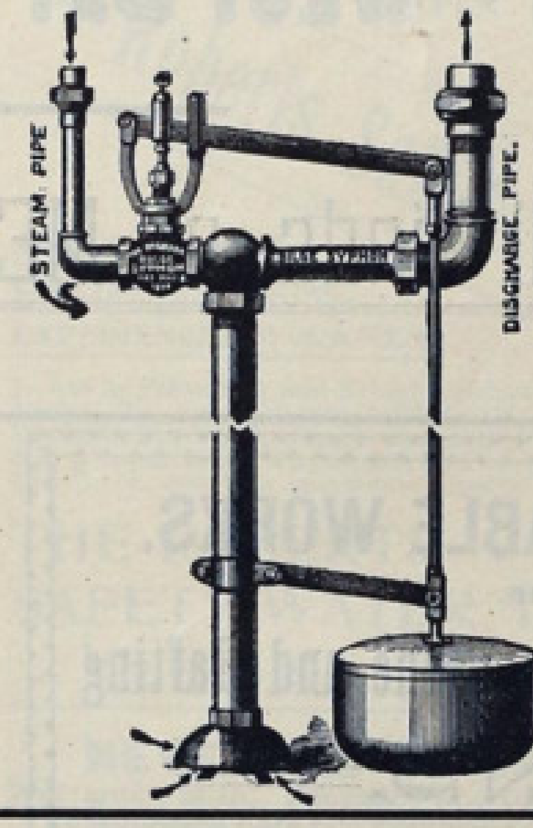

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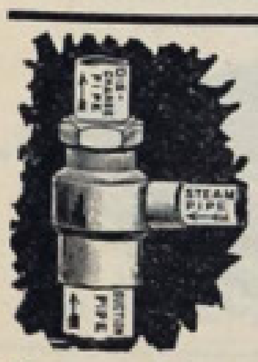

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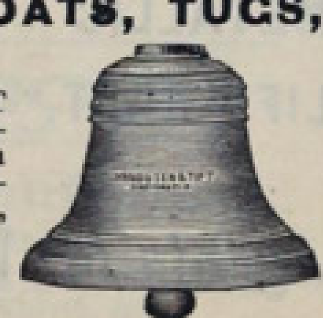

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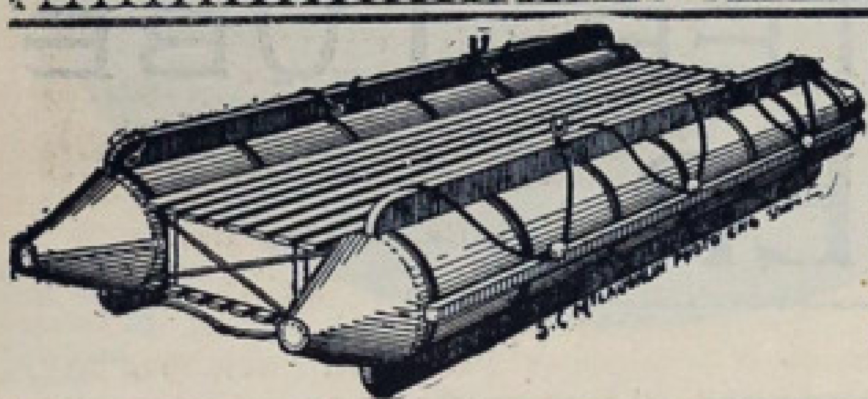

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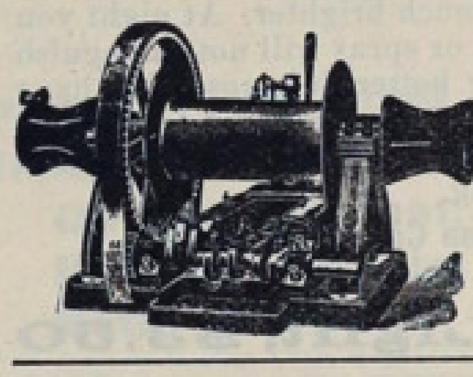

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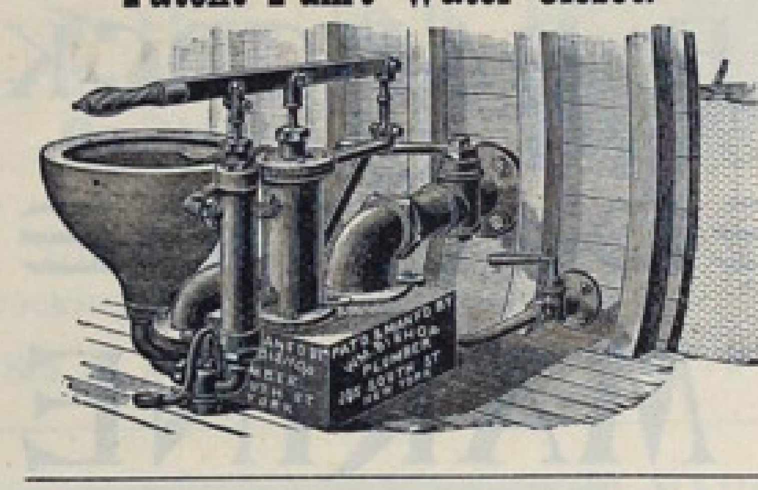

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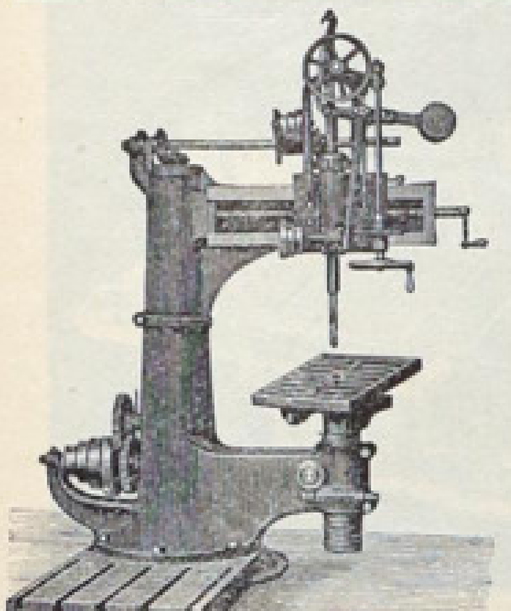

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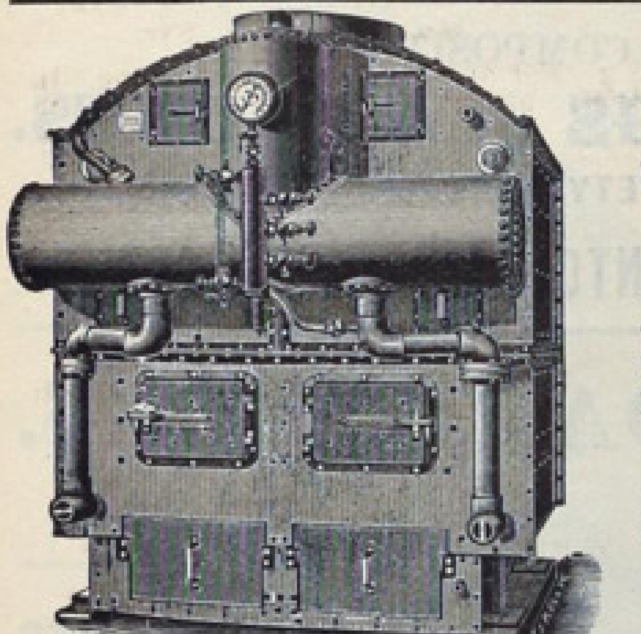

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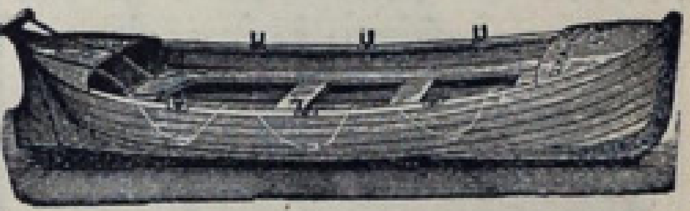

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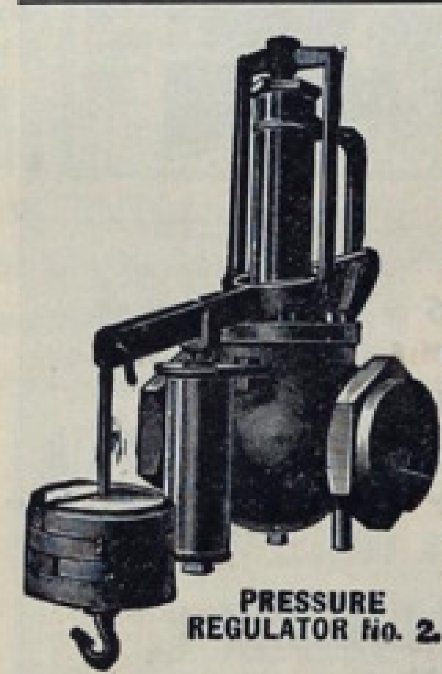

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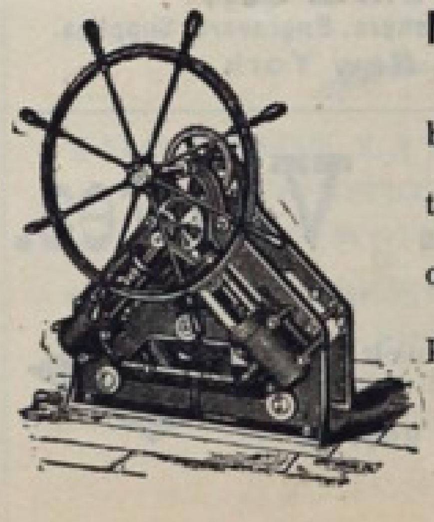

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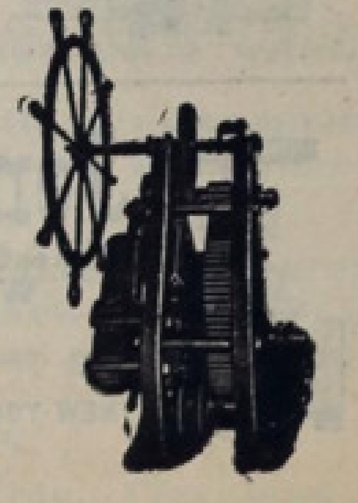

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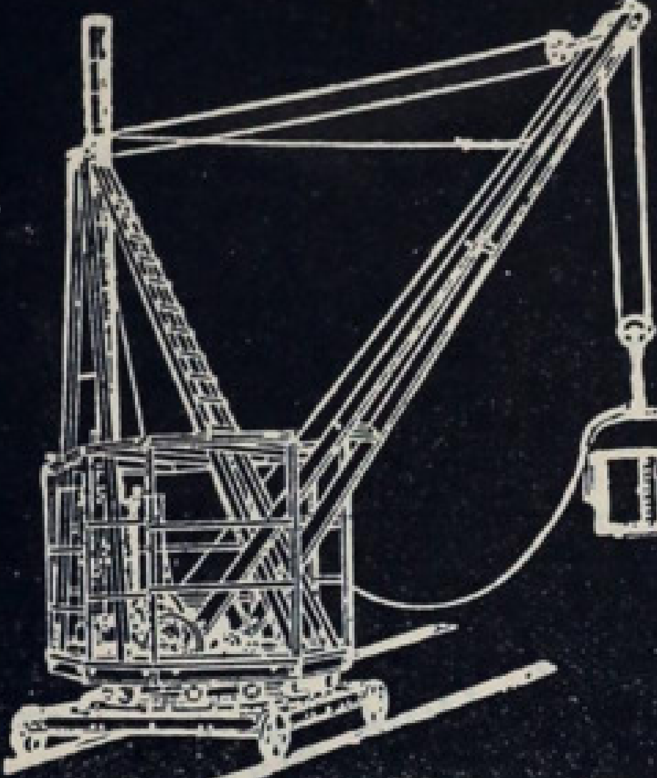

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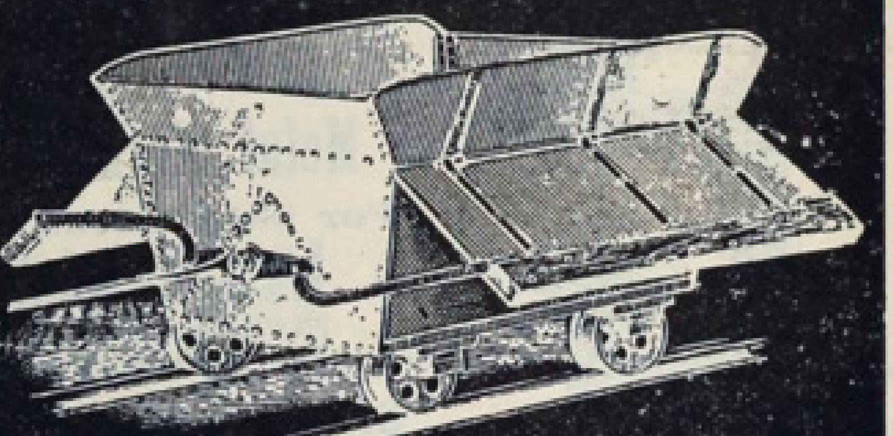

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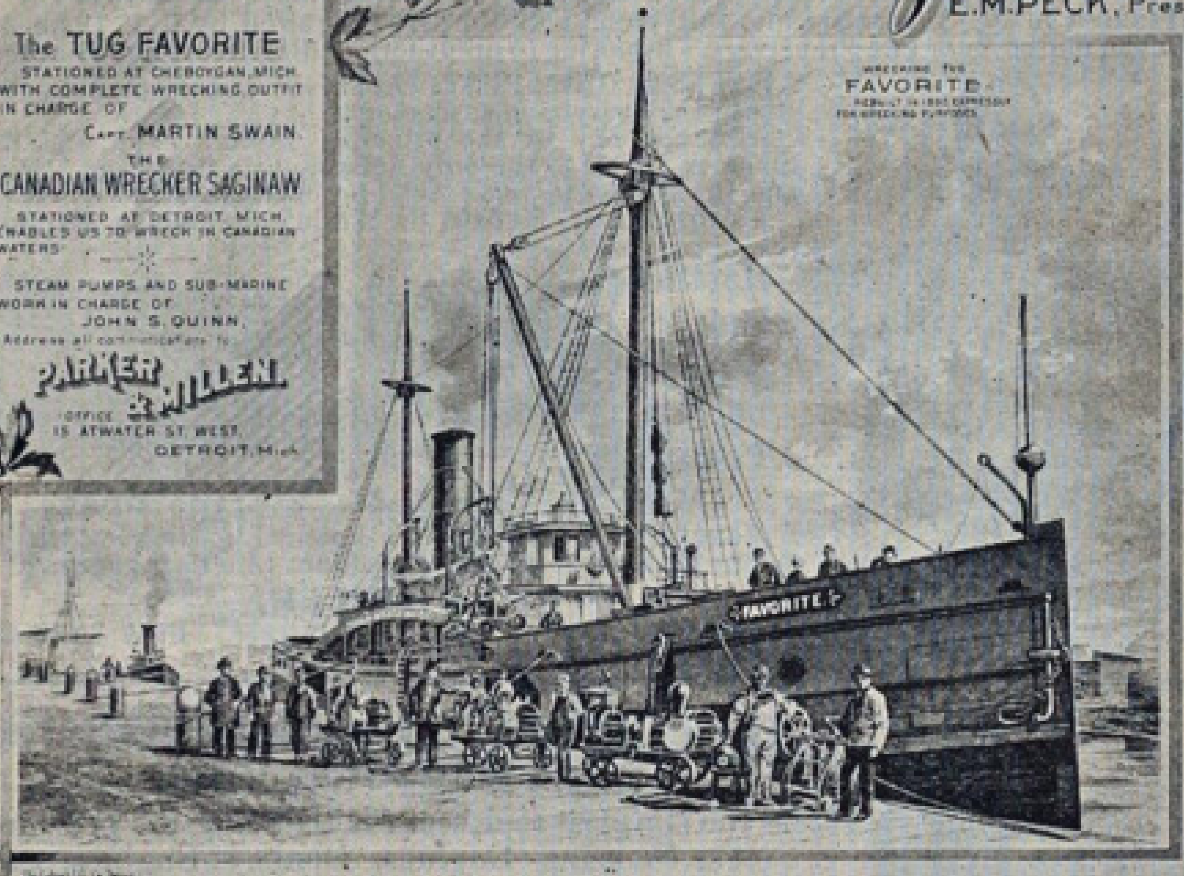

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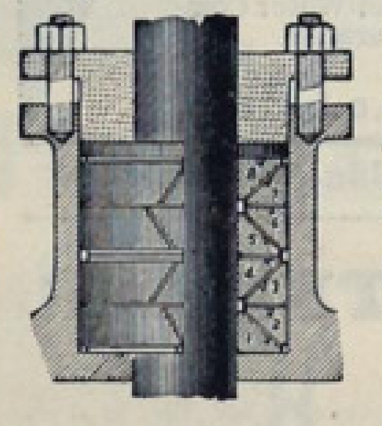

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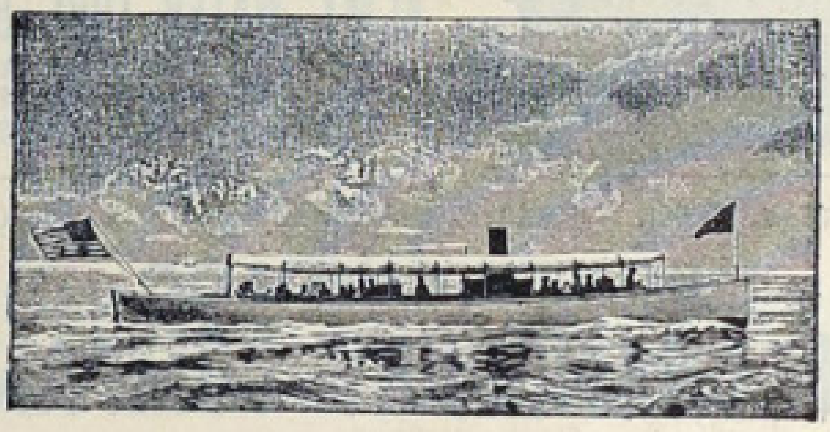

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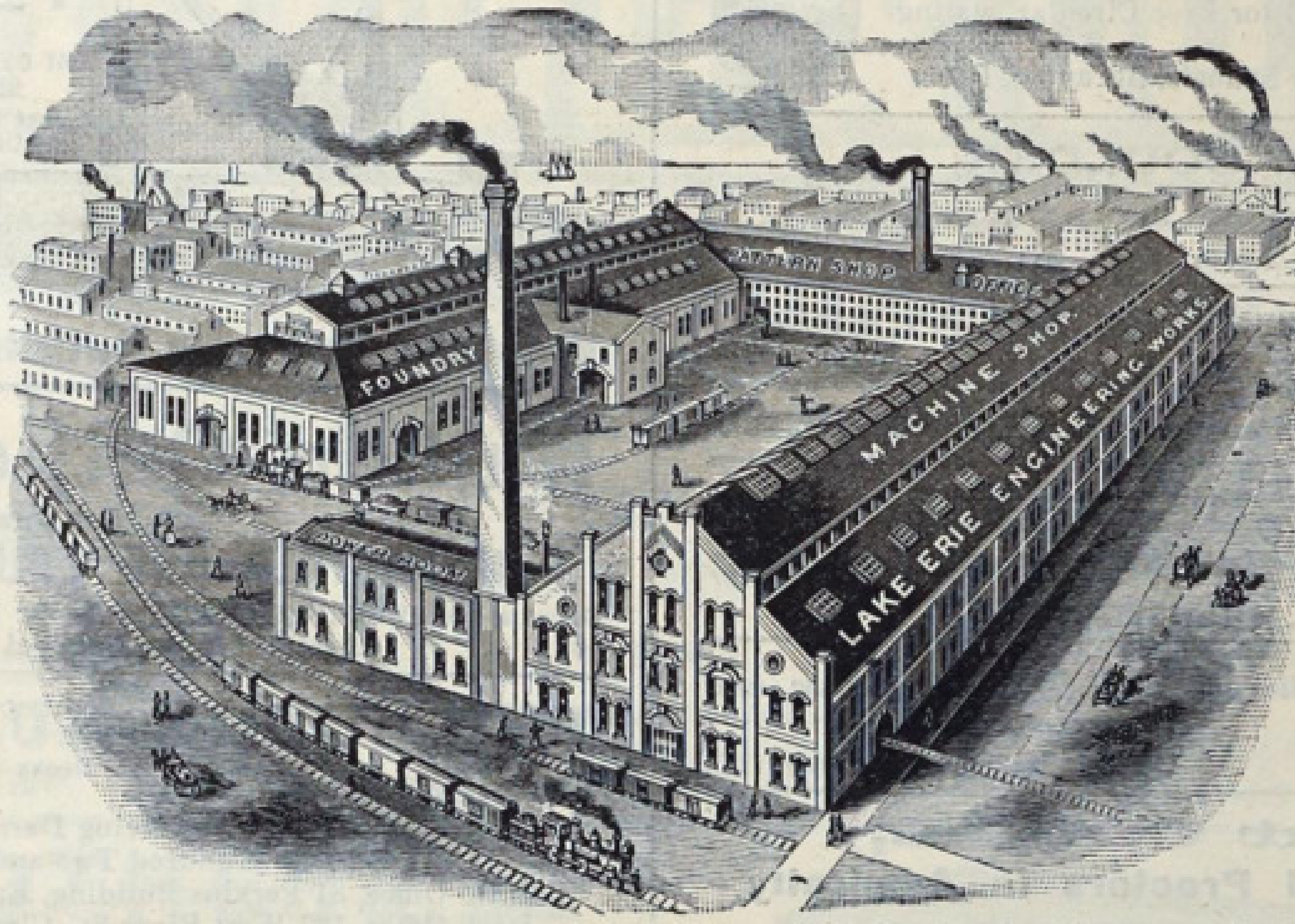

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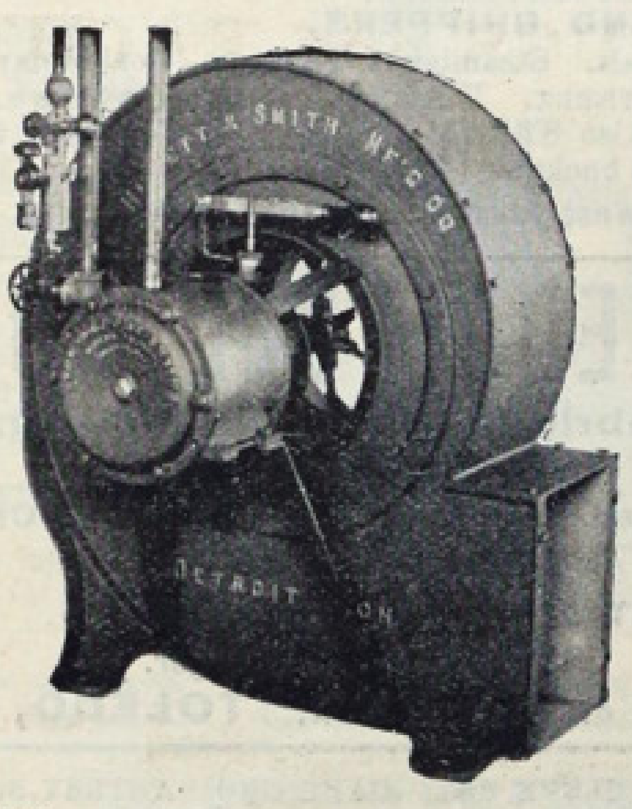

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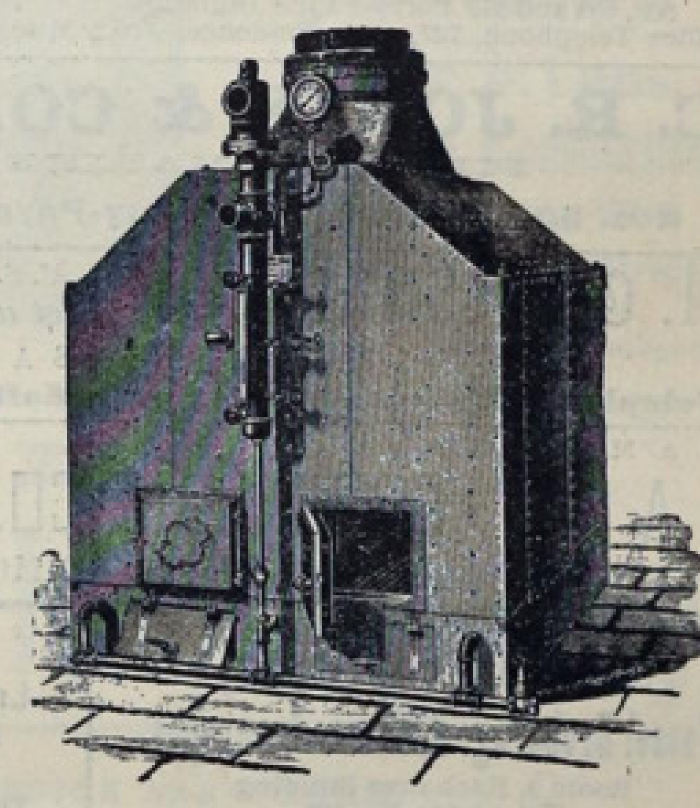

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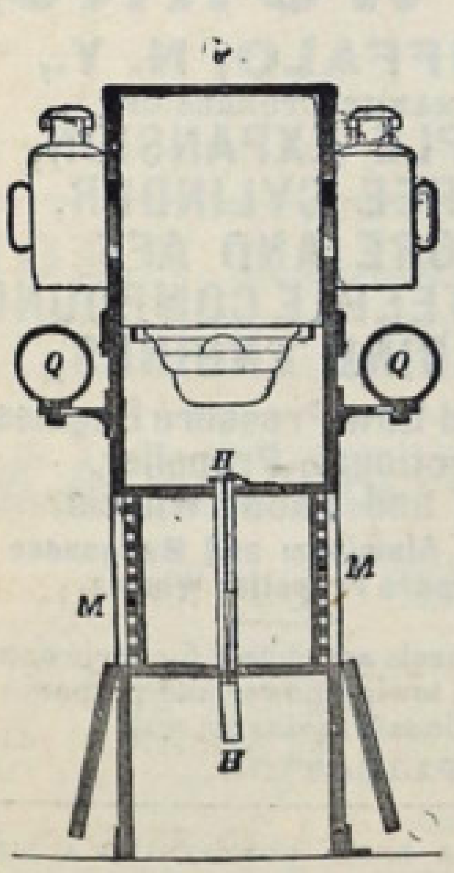

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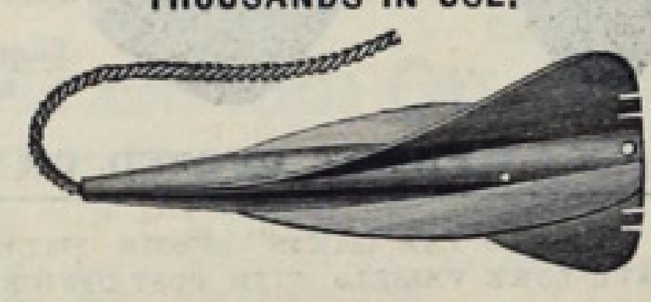

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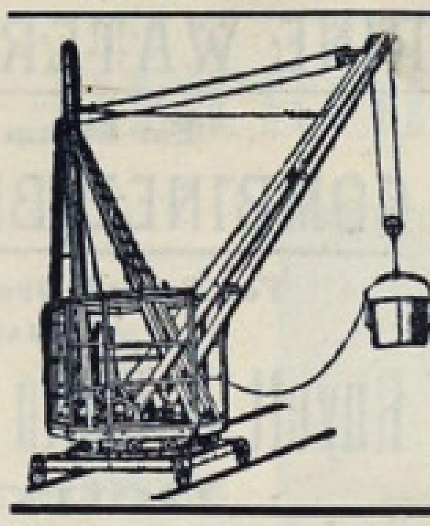

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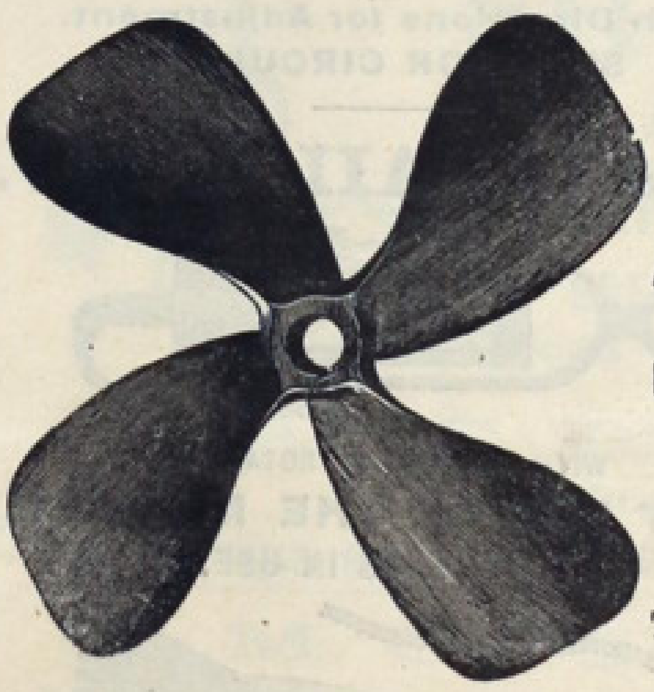

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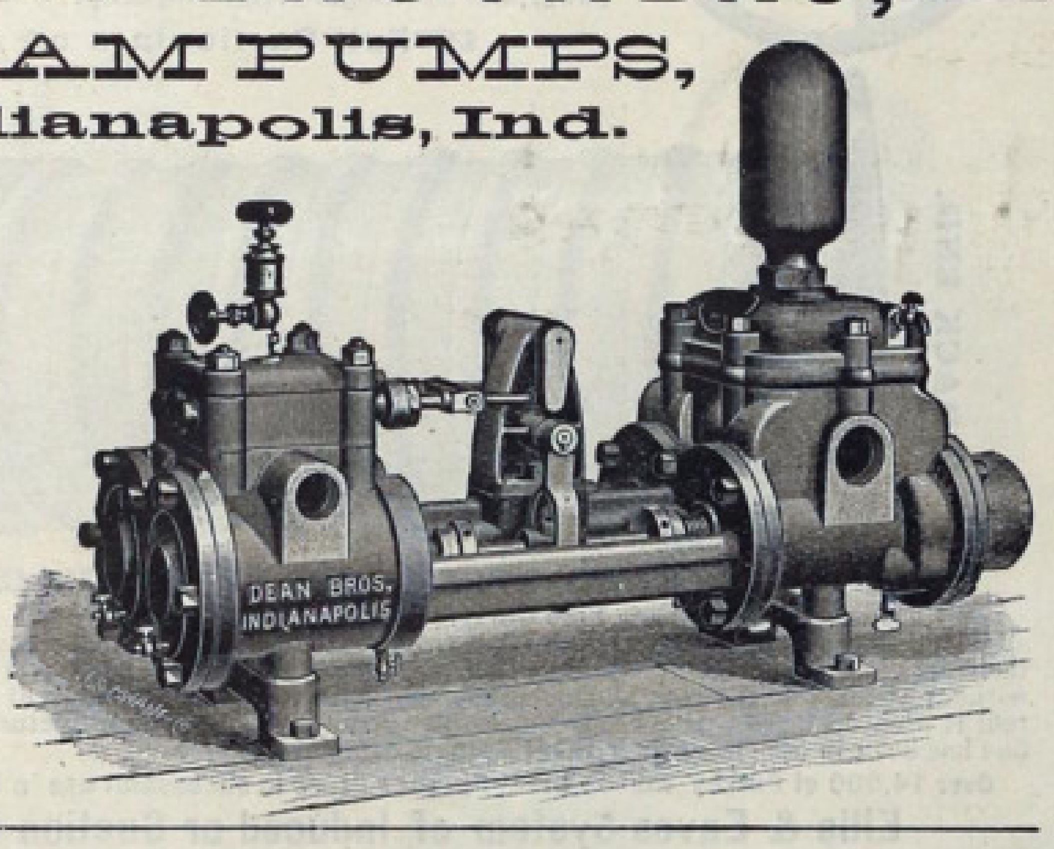

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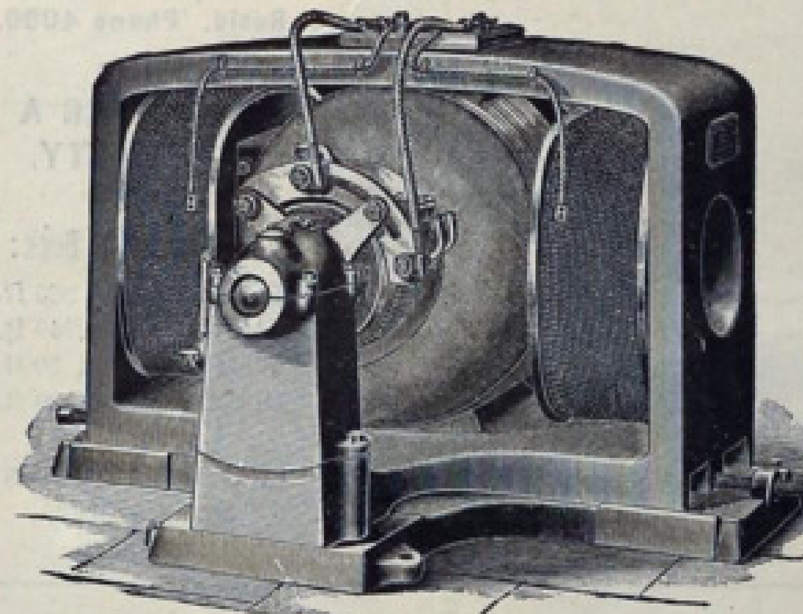

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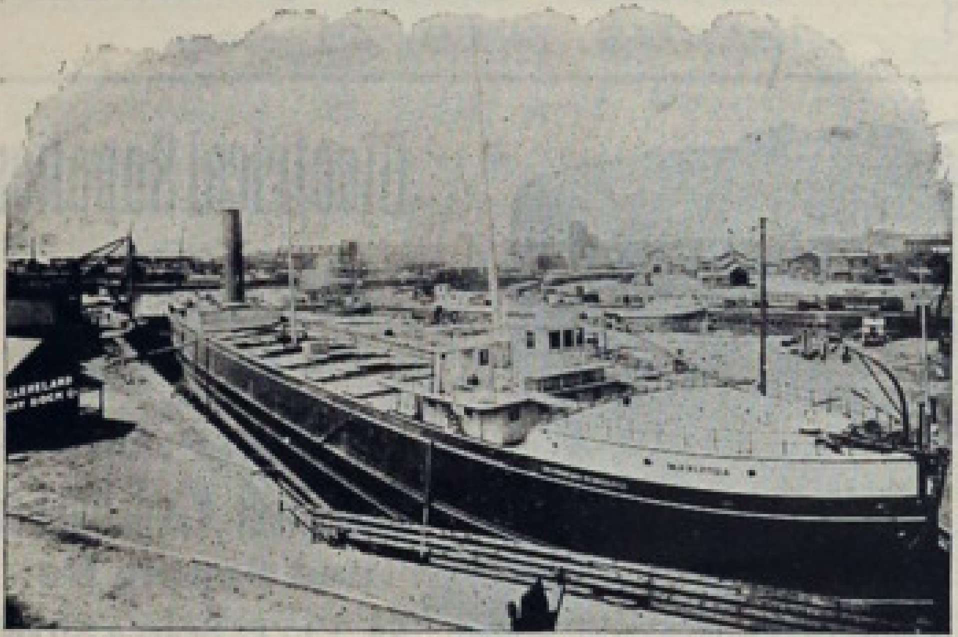

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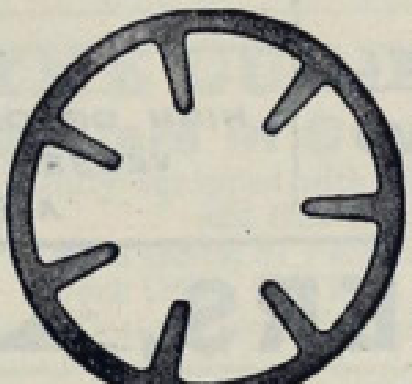

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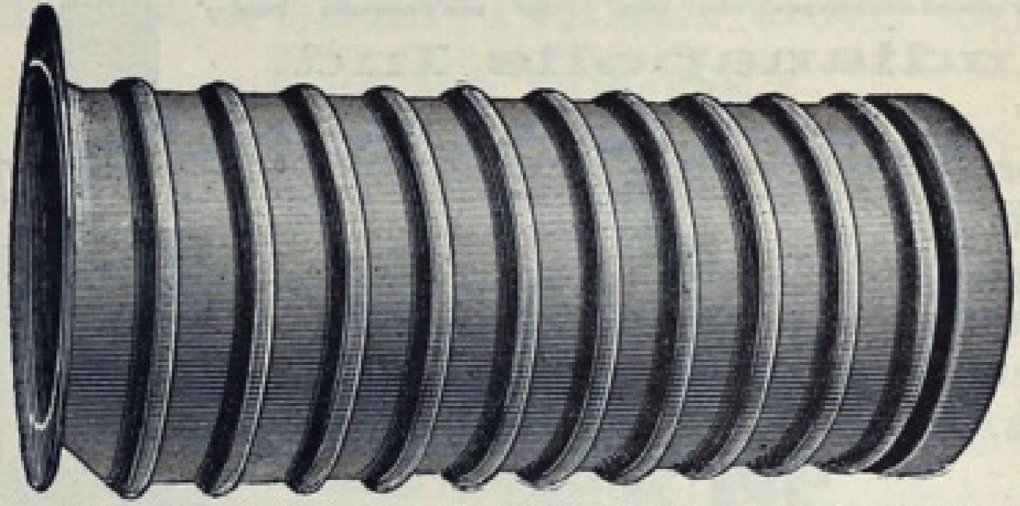

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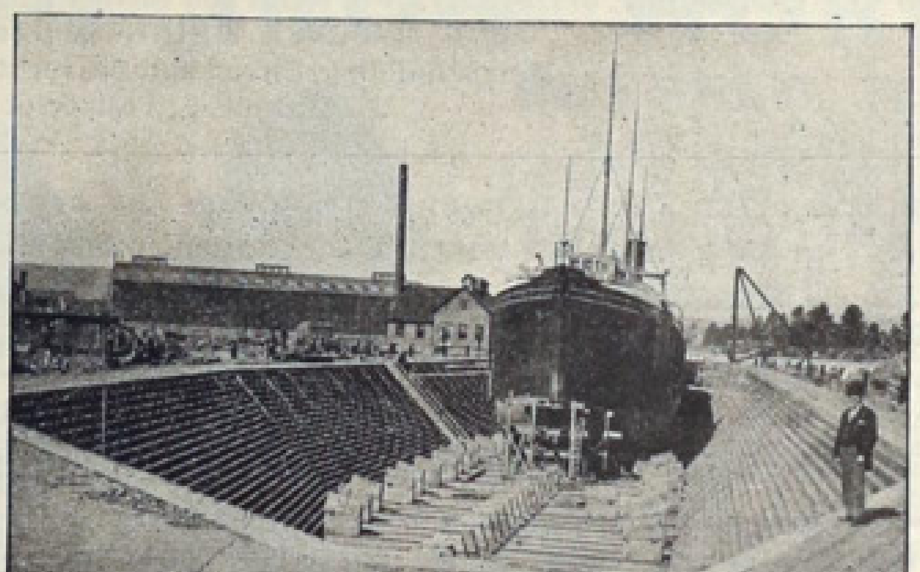

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